Photo by Mickey Prim, Manley & Prim Photography, Inc.

Customer Profil

Producing

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The first electricity produced from a geothermal source was generated in Lardarello, Italy, in 1913. That plant used naturally occurring dry steam directed into a turbine to drive a generator. This method is still used today, but the number of dry steam reservoirs is limited.

Single- and Double-flash plants use more plentiful hot water (geothermal brine) reservoirs. As the brine exits the reservoir rock and depressurizes at the surface, some of it will flash to steam. If this flashing process is contained in a vessel, the steam can be used to run a turbine.

When the brine temperature is not high enough to produce sufficient steam, it is kept as a pressurized liquid and used to heat another fluid that almost completely evaporates at a relatively low temperature. This "binary" method is used at Steamboat Springs, south of Reno, Nevada.

The Steamboat Geothermal Plant is owned by Far West Capital and has eighteen full-time employees. It is composed of three separate units, Steamboat 1, 2 and 3. Steamboat 1 was built in 1986 as a pilot project. Steamboat 2 and 3 were finished ahead of schedule and became operational in December 1992. Together, the plants produce over 24 MW net of electricity, enough to supply 24,000 homes.

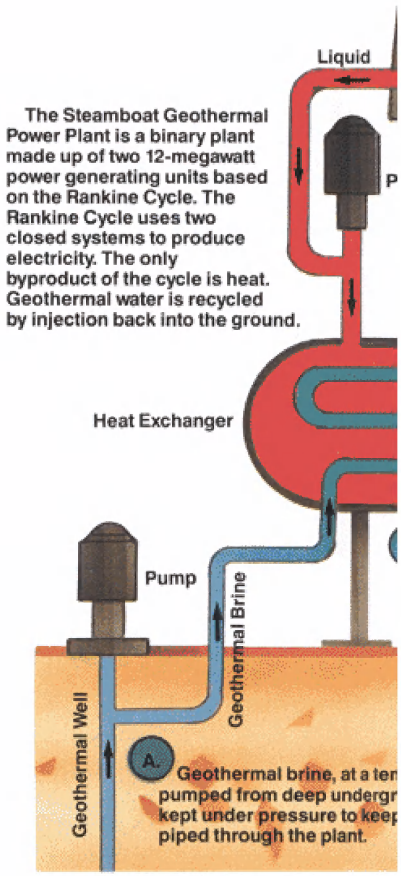
Geothermal process

Steamboat 2&3 use two separate closed loops, one consisting of geothermal brine, and the other containing isobutane. Brine at 310° to 330°F (155° to 166°C) is pumped from nine underground wells using nine 450 horsepower, motor-driven, sixteen stage vertical centrifugal pumps. The wells extend 590 to 2700 feet (180 to 823 meters) below ground and were drilled through fractured granite, a very expensive process. Often drill bits, at a cost of $10,000 to $20,000 each, were replaced after only 20 to 30 feet (6 to 9 meters) of drilling. Each well pumps an average of 1800 gallons (6813 liters) per minute.

A bubbler tube is used to measure brine levels. By monitoring these levels, operators know they are not drawing down the underground reservoir. The water pressure never varies, and well levels are very stable. The brine remains a pressurized liquid as it is piped to twelve forty-foot long heat exchangers. Heat exchanger pressures and temperatures are carefully controlled to minimize fouling.

As the geothermal brine is piped through one side of the heat exchanger, isobutane is pumped through the other side by six 1100 horsepower pumps. Isobutane's 11°F (–12°C) boiling point makes it a good medium for use in a binary plant. The isobutane flashes to vapor, which drives four single stage radial flow turbines which were built by Rotoflow, a subsidiary of Atlas Copco.

Each turbine has a 22 inch titanium wheel and runs at 9050 rpm. After passing through the turbines, the isobutane goes through 240 Hudson fin fans (air-



The Steamboat Geothermal Power Plant is a binary plant made up of two 12-megawatt power generating units based on the Rankine Cycle. The Rankine Cycle uses two closed systems to produce electricity. The only byproduct of the cycle is heat. Geothermal water is recycled by injection back into the ground.

ıg electricity from geothermal brine

ıt recognized by Governor on Geothermal Power Awareness Day

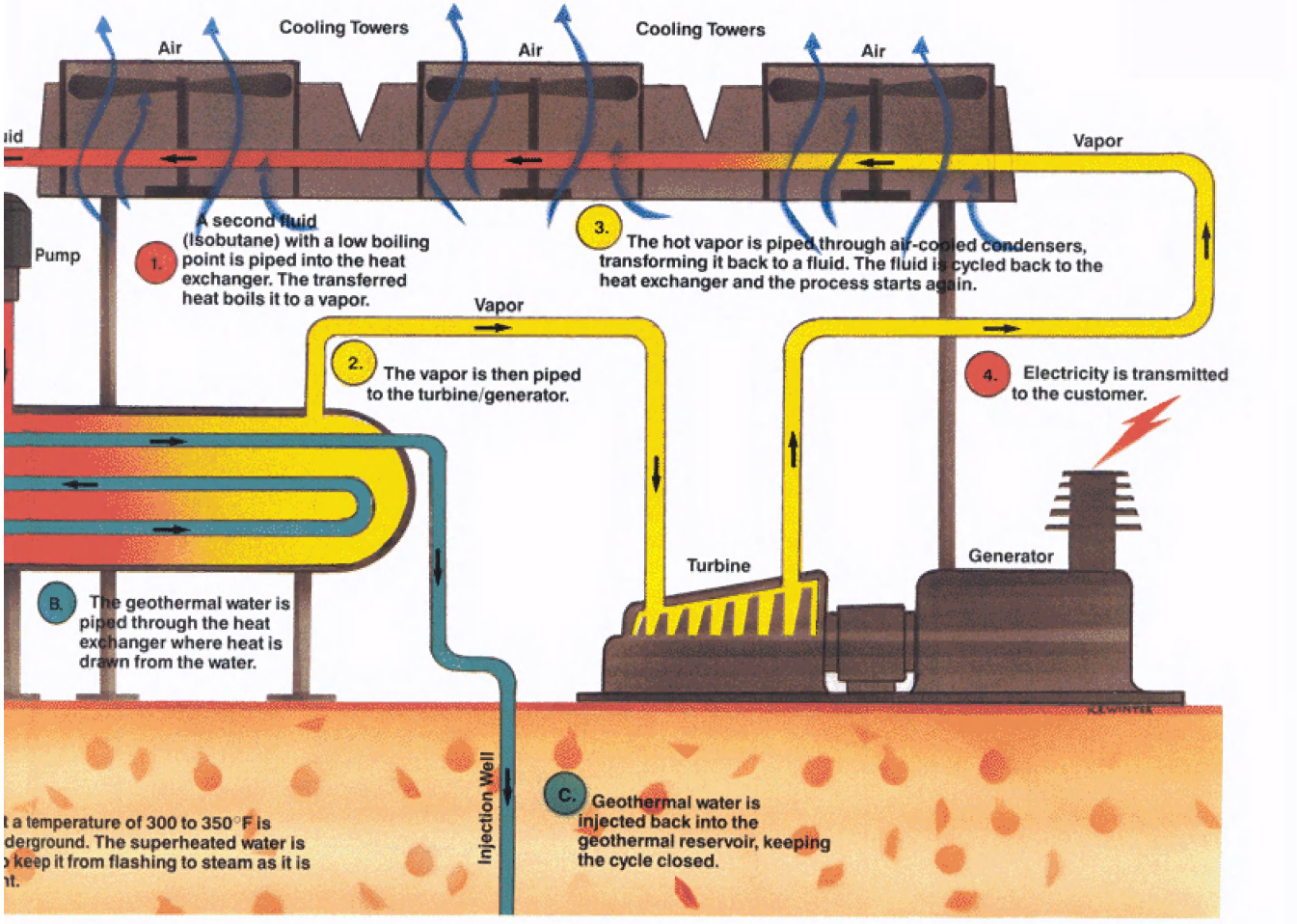


Figure developed from original concept drawing by Reno Gazette-Journal artist, Mark Nowlin.

condensers) to cool it back to liquid. The fluid is sent back to an accumulator, and the process is repeated. No cooling water is used in the plant; it is completely air-cooled. The geothermal brine is reinjected into the geothermal reservoir.

Because of lower ambient temperatures during the fall and winter, operators can get 25% more power from Steamboat 2 and 3, or 12.8 MW for each unit. The turbine's efficiency rate is 85%; the plant's efficiency rate is in the high 20% to low 30% range.

Steamboat 1 is older and uses pentane instead of isobutane, but the basic process is similar.

Safety

Plant operators are very safety-conscious. Gas detectors are located►

throughout the plant and automatic alarms call a security firm that notifies the fire department. Automatic water systems are located in many sections of the plant. The plant is environmentally safe and has never had a gas leak.

Benefits of the 3300 Monitoring System

The plant uses four Bently Nevada 3300 Monitoring Systems to monitor vibration levels and bearing temperatures on their turbines and generators. Each system consists of a power supply, System Monitor, two Dual Vibration Monitors, two 6-channel Temperature Monitors and a Tachometer. Two proximity probes are mounted 90 degrees apart on each bearing to supply vibration information. The temperature monitors feed back information on the bearings and generator windings. Operators have monitored vibration since their first day of operation.

The proximity probes proved very useful during the startup of Steamboat 2 and 3. Oscilloscope signatures were recorded and proved to be valuable data. That data, along with other measurements, was used to modify the turbine wheels. Based on the vibration data, the journal bearings were also changed from a four pad design to a five pad design.

Plants 2 and 3 use a Bailey Distributed Control System for process control. The system trends parameters such as fluid levels, pressures, and temperatures, and records any alarms and trips from the Bently Nevada 3300 System.

Conclusion

Operators are very pleased with the operation and quality of their 3300 Systems and the information they have provided. The vibration levels are monitored closely by plant personnel, and provide an extra measure of safety and reliability at this innovative plant.

Bob Miller, Governor of Nevada, recently proclaimed April 22, 1993 as Geothermal Power Awareness Day in recognition of Steamboat Springs' development of an environmentally benign, technically-advanced binary geothermal power plant. ■